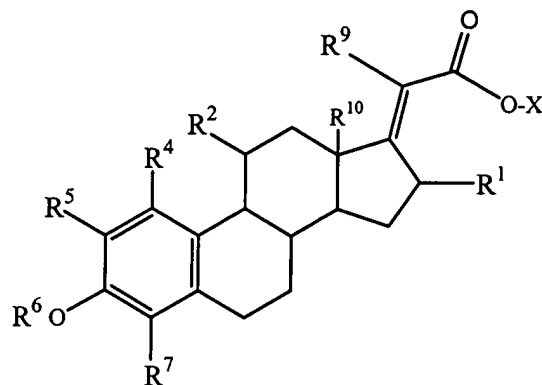


WE CLAIM:

1. A compound having the structural formula (I)

(I)



wherein:

X is lower hydrocarbyl;

R¹ is CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, -OR¹³, and -SR¹³

wherein R¹³ is alkyl;

R⁴, R⁵, R⁶, and R⁷ are independently selected from the group consisting of hydrogen and lower alkyl;

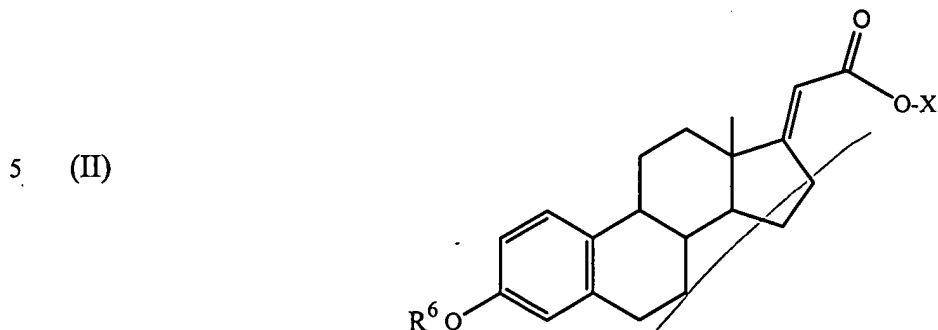
R⁹ is hydrogen or hydrocarbyl; and

R¹⁰ is methyl or ethyl.

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2. The compound of claim 1, having the structural formula (II)



wherein:

10 X is lower alkyl; and

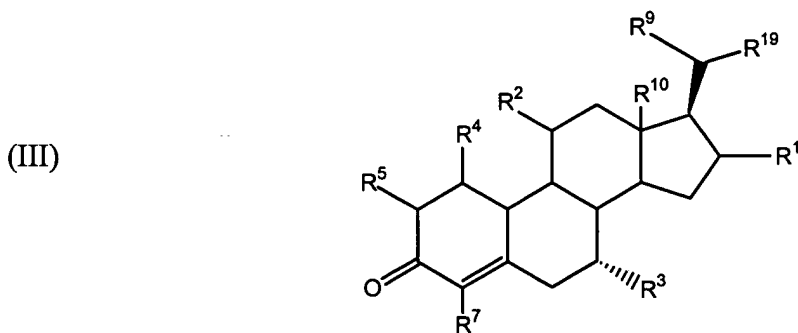
R^6 is selected from the group consisting of hydrogen and lower alkyl.

3. The compound of claim 2, wherein R^6 is hydrogen.

- 15 4. The compound of claim 2, wherein R^6 is lower alkyl.

5. The compound of claim 4, wherein R^6 is methyl.

- 20 6. A compound having the structural formula (III)



wherein:

30 R^1 is $CR^{11}R^{12}$, wherein R^{11} and R^{12} are hydrogen or lower alkyl;

R^2 is selected from the group consisting of hydrogen, hydroxyl, alkyl, $-OR^{13}$, and $-SR^{13}$

Ch
6-13
selected

-53-

wherein R^{13} is alkyl;

R^3 is selected from the group consisting of hydrogen and hydrocarbyl;

R^4 , R^5 , and R^7 are independently hydrogen or lower alkyl;

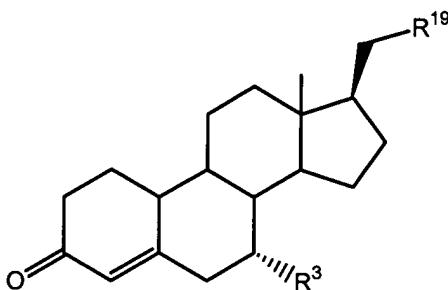
R^9 is hydrogen or hydrocarbyl;

R^{10} is methyl or ethyl; and

R^{19} is hydroxyl, hydroxymethyl, protected hydroxyl, protected hydroxymethyl, activated hydroxyl, or activated hydroxymethyl.

7. The compound of claim 6, having the structural formula (IV)

(IV)



wherein:

R^3 is hydrogen or lower alkyl; and

R^{19} is hydroxyl, hydroxymethyl, -O-acetyl, or -O-tetrahydropyranyl.

8. The compound of claim 7, wherein R^3 is hydrogen or methyl, and R^{19} is hydroxymethyl.

9. The compound of claim 8, wherein R^3 is hydrogen.

10. The compound of claim 8, wherein R^3 is methyl.

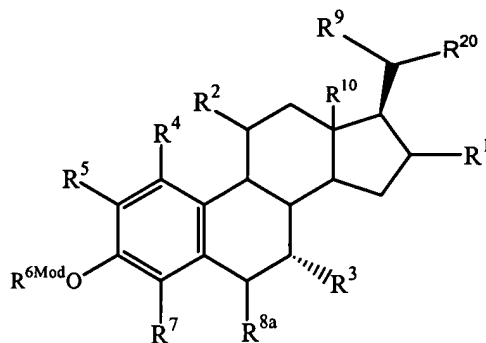
11. The compound of claim 7, wherein R^3 is hydrogen or methyl, and R^{19} is hydroxyl.

12. The compound of claim 11, wherein R^3 is hydrogen.

13. The compound of claim 11, wherein R³ is methyl.

14. A compound having the structural formula (V)

(V)



wherein:

R¹ is hydrogen or CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, -OR¹³, and -SR¹³

wherein R¹³ is alkyl;

R³ is selected from the group consisting of hydrogen and hydrocarbyl;

R⁴, R⁵, and R⁷ are independently selected from the group consisting of hydrogen and lower alkyl;

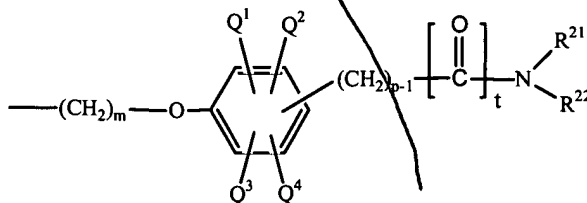
R^{6Mod} is selected from the group consisting of hydrogen, alkyl, acyl, -C(O)-aryl, -C(O)-alkyl, hydroxyl-protecting groups, and hydroxyl-activating groups;

R^{8a} is selected from the group consisting of hydrogen, hydroxyl, oxo, and -OR¹⁸ wherein R¹⁸ is lower alkyl or lower acyl;

R⁹ is hydrogen or alkyl;

R¹⁰ is methyl or ethyl; and

R²⁰ is hydroxyl, hydroxymethyl, protected hydroxyl, protected hydroxymethyl, activated hydroxyl, activated hydroxymethyl, or

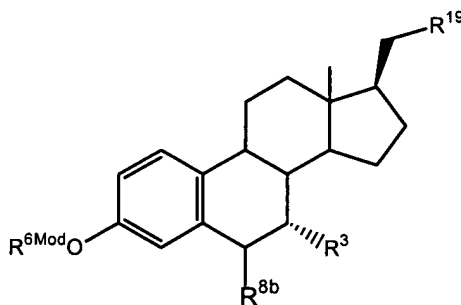


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in which m is zero or 1, p is an integer in the range of 1 to 7 inclusive, t is zero or 1, with the proviso that when R^{8a} is oxo, t is 1, and when R^{8a} is hydrogen, t is zero, and R²¹ and R²² are lower alkyl or are linked together to form a five- or six-membered heterocycloalkyl ring; and

Q¹, Q², Q³, and Q⁴ are independently selected from the group consisting of hydrogen, hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino.

15. The compound of claim 14, having the structural formula (VI)

(VI)



wherein:

R³ is hydrogen or lower alkyl;

R^{6Mod} is hydrogen or a hydroxyl-protecting group;

R^{8b} is selected from the group consisting of hydrogen, hydroxyl, and oxo; and

R¹⁹ is hydroxyl, hydroxymethyl, protected hydroxyl, protected hydroxymethyl, activated hydroxyl, or activated hydroxymethyl.

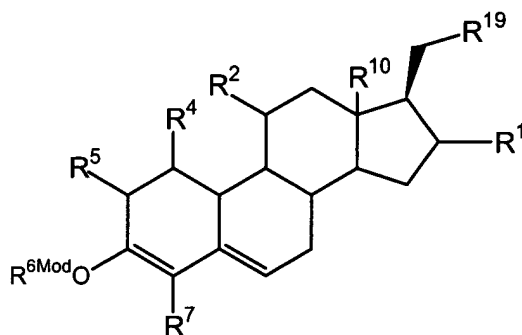
16. The compound of claim 15, wherein R³ is hydrogen or methyl, R^{6Mod} is hydrogen or lower alkyl, R^{8b} is oxo, and R¹⁹ is hydroxyl, hydroxymethyl, -O-acetyl, or -O-tetrahydropyranyl.

17. The compound of claim 16, wherein R³ is methyl.

SUB
A2
18. The compound of claim 17, wherein R^{6Mod} is isopropyl.

19. A compound having the structural formula (XXVII)

5 (XXVII)



10 wherein:

R^1 is hydrogen or $CR^{11}R^{12}$, wherein R^{11} and R^{12} are hydrogen or lower alkyl;

R^2 is selected from the group consisting of hydrogen, hydroxyl, alkyl, $-OR^{13}$, and $-SR^{13}$ wherein R^{13} is alkyl;

15 R^4 , R^5 , and R^7 are independently selected from the group consisting of hydrogen and lower alkyl;

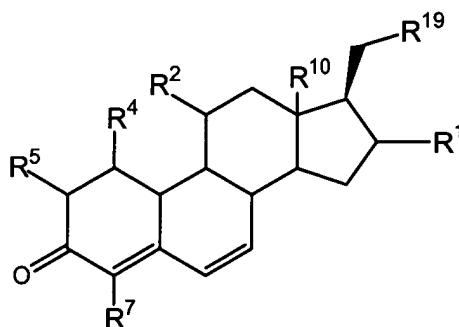
R^{6Mod} is selected from the group consisting of hydrogen, alkyl, acyl, $-C(O)$ -aryl, $-C(O)$ -alkyl, hydroxyl-protecting groups, and hydroxyl-activating groups;

R^{10} is methyl or ethyl; and

20 R^{19} is hydroxyl, hydroxymethyl, protected hydroxyl, protected hydroxymethyl, activated hydroxyl, or activated hydroxymethyl.

20. A compound having the structural formula (XXVIII)

5 (XXVIII)



10 wherein:

R¹ is hydrogen or CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, -OR¹³, and -SR¹³

wherein R¹³ is alkyl;

R⁴, R⁵, and R⁷ are independently selected from the group consisting of hydrogen and

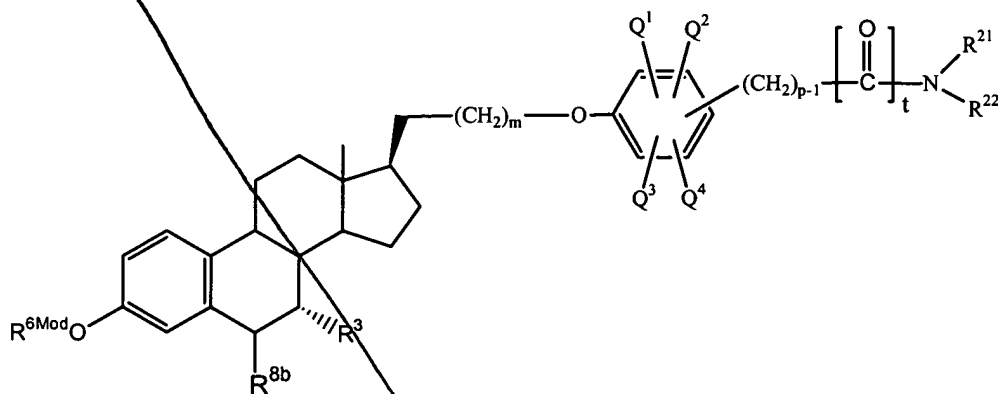
15 lower alkyl;

R¹⁰ is methyl or ethyl; and

R¹⁹ is hydroxyl, hydroxymethyl, protected hydroxyl, protected hydroxymethyl, activated hydroxyl, or activated hydroxymethyl.

20 Sub
A3 21. A compound having the structural formula (VII)

(VII)



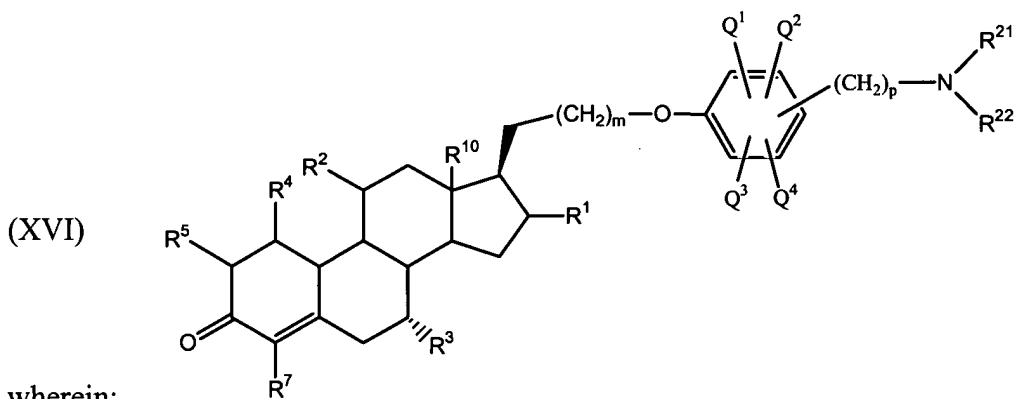
wherein:

30 R³ is hydrogen or hydrocarbyl;

-58-

A3
Cest
R^{6Mod} is selected from the group consisting of hydrogen, alkyl, acyl, -C(O)-aryl, and
-C(O)-alkyl, hydroxyl-protecting groups, and hydroxyl-activating groups;
R^{8b} is selected from the group consisting of hydrogen, hydroxyl, and oxo;
m is zero or 1;
p is an integer in the range of 1 to 7 inclusive;
t is zero or 1, with the proviso that when R^{8a} is oxo, t is 1, and when R^{8a} is hydrogen, t
is zero, and;
R²¹ and R²² are lower alkyl or are linked together to form a five- or six-membered
heterocycloalkyl ring; and
Q¹, Q², Q³, and Q⁴ are independently selected from the group consisting of hydrogen,
hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino.

22. A compound having the structural formula (XVI)



wherein:

R¹ is CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, -OR¹³, and -SR¹³

wherein R¹³ is alkyl;

R³ is hydrogen or hydrocarbyl;

R⁴ and R⁵ are independently selected from the group consisting of hydrogen and lower
alkyl;

R⁷ is hydrogen or lower alkyl;

R¹⁰ is methyl or ethyl;

m is zero or 1;

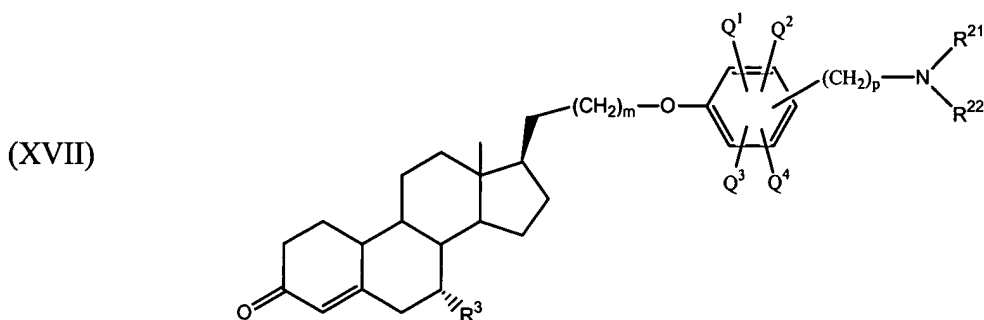
-59-

p is an integer in the range of 1 to 7 inclusive;

R²¹ and R²² are lower alkyl or are linked together to form a five- or six-membered heterocycloalkyl ring; and

Q¹, Q², Q³, and Q⁴ are independently selected from the group consisting of hydrogen, hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino, or a pharmacologically acceptable acid addition salt thereof.

23. The compound of claim 22, having the structural formula (XVII)



wherein:

m is zero or 1;

p is an integer in the range of 1 to 7 inclusive;

R³ is hydrogen or lower alkyl;

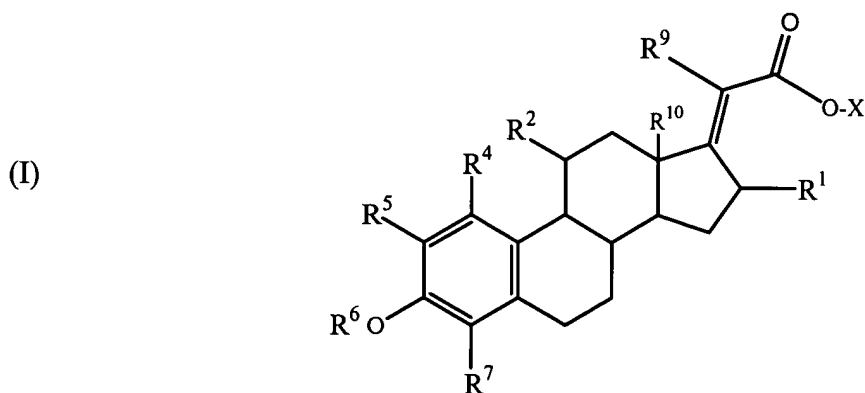
R²¹ and R²² are lower alkyl or are linked together to form a five- or six-membered heterocycloalkyl ring; and

Q¹, Q², Q³, and Q⁴ are independently selected from the group consisting of hydrogen, hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino, or a pharmacologically acceptable acid addition salt thereof.

24. The compound of claim 21, wherein R³ is lower alkyl.

25. The compound of claim 22, wherein R³ is methyl.

26. A method for synthesizing 21-hydroxy-19-norpregna-4-en-one and substituted analogs thereof, comprising treating a starting material having the structural formula (I)



with an alkali metal in the presence of ammonia or an alkylamine, wherein, in formula (I),

X is lower hydrocarbyl;

R¹ is CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, -OR¹³, and -SR¹³

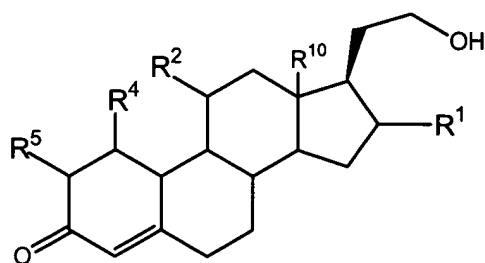
wherein R¹³ is alkyl;

R⁴, R⁵, R⁶, and R⁷ are independently selected from the group consisting of hydrogen and lower alkyl;

R⁹ is hydrogen or hydrocarbyl; and

R¹⁰ is methyl or ethyl, resulting in a reaction product having the structural formula

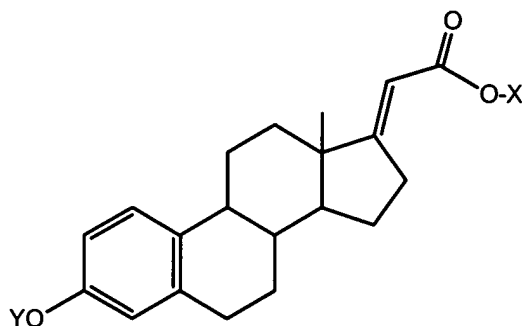
(VIII)



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27. A method for synthesizing 21-hydroxy-19-norpregna-4-en-3-one, comprising treating (IX)

(IX)

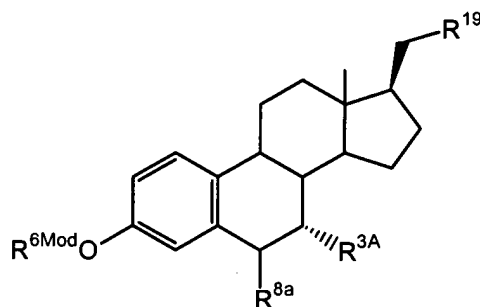


wherein X and Y are independently lower alkyl, with an alkali metal in the presence of ammonia or an alkylamine.

28. A method for synthesizing a 7-alkyl-6-keto-1,3,5(10) estratriene, comprising contacting a 19-norpregna-4-en-3-one with gaseous oxygen in the presence of base, followed by reaction of the intermediate so provided with an alkyl halide.

29. A method for synthesizing a 7-alkyl-6-keto-1,3,5(10) estratriene having the structural formula (VIa)

(VIa)



wherein:

R^{3A} is lower alkyl;

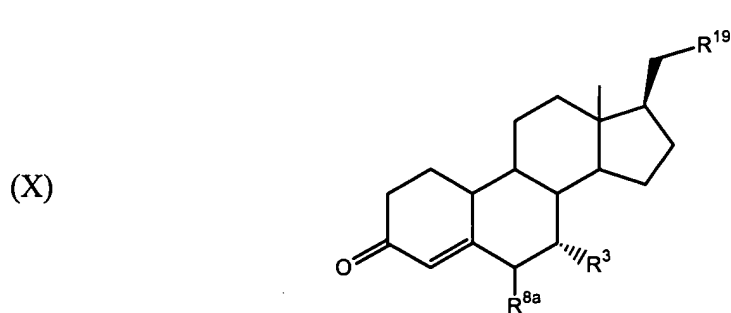
R^{6Mod} is hydrogen or a hydroxyl-protecting group;

R^{8a} is hydrogen or oxo; and

-62-

R^{19} is hydroxyl, hydroxymethyl, protected hydroxyl, or protected hydroxymethyl, the method comprising the steps of

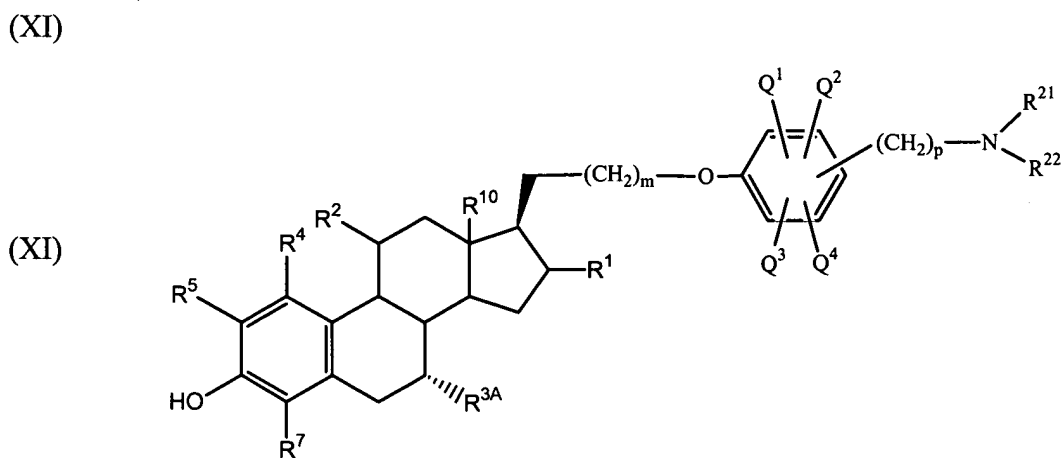
- (a) contacting the 19-norpregna-4-en-3-one (X)



with oxygen in the presence of a base;

- (b) protecting the 3-hydroxyl group thus formed with a protecting group, and
(c) treating the 3-hydroxyl-protected intermediate with an alkyl halide.

30. A method for synthesizing an anti-estrogenic steroid having the structural formula



wherein:

R^1 is $CR^{11}R^{12}$, wherein R^{11} and R^{12} are hydrogen or lower alkyl, and when R^1 is absent, R^1 is hydrogen or alkyl;

R^2 is selected from the group consisting of hydrogen, hydroxyl, alkyl, and $-OR^{13}$

wherein R^{13} is alkyl;

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R^{3A} is lower alkyl;

R^4 , R^5 , R^6 , and R^7 are independently selected from the group consisting of hydrogen and lower alkyl; and

R^{10} is methyl or ethyl;

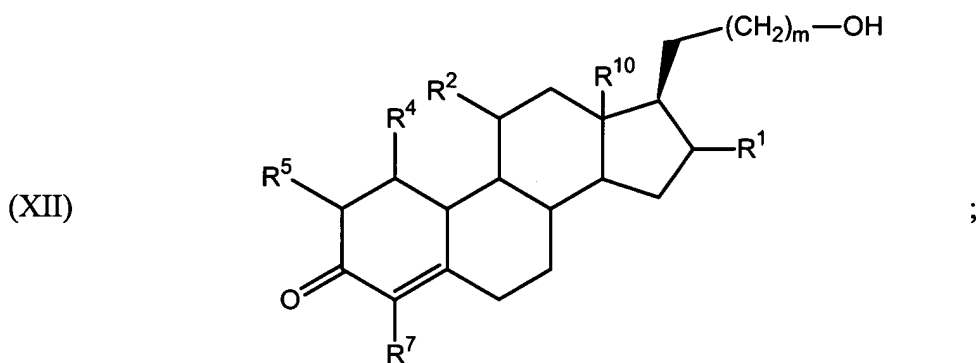
m is zero or 1;

p is an integer in the range of 1 to 7 inclusive;

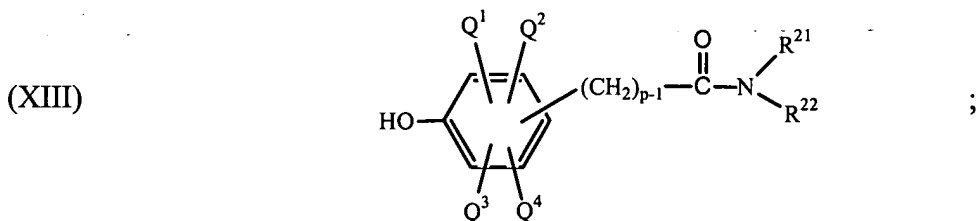
R^{21} and R^{22} are lower alkyl or are linked together to form a five- or six-membered heterocycloalkyl ring; and

Q^1 , Q^2 , Q^3 , and Q^4 are independently selected from the group consisting of hydrogen, hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino, said method comprising:

(a) providing a starting material having the structural formula (XII)



(b) converting the -OH group to an -O-LG moiety wherein LG is a leaving group displaceable by nucleophilic attack, and displacing LG by reaction with a hydroxyl-containing compound having the structural formula (XIII)



(c) oxidizing the A ring and providing a 6-keto moiety by exposure to gaseous oxygen in the presence of base;

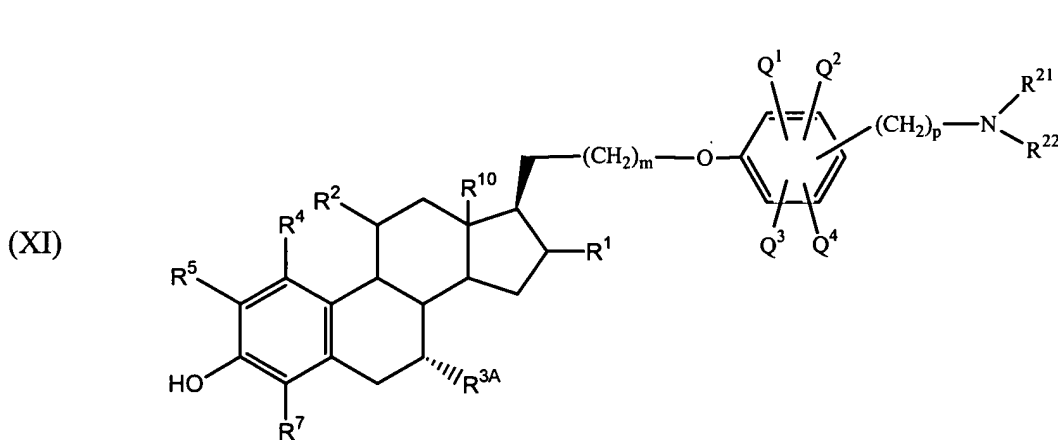
(d) protecting the 3-hydroxyl group with a protecting group;

(e) contacting the product of step (d) with an alkyl halide, to provide a 7 α -alkyl substituent; and

(f) reducing the compound so provided to remove all keto moieties, with the proviso that steps (c) and (d) may occur prior to or simultaneously with step (b).

31. The method of claim 30, further including (g) treating the product of step (f) with an acid to produce an acid addition salt.

32. A method for synthesizing an anti-estrogenic steroid having the structural formula (XI)



wherein:

R¹ is CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, and -OR¹³

wherein R¹³ is alkyl;

R^{3A} is lower alkyl;

R⁴, R⁵, R⁶ and R⁷ are independently selected from the group consisting of hydrogen and

lower alkyl; and

-65-

R^{10} is methyl or ethyl.

m is zero or 1;

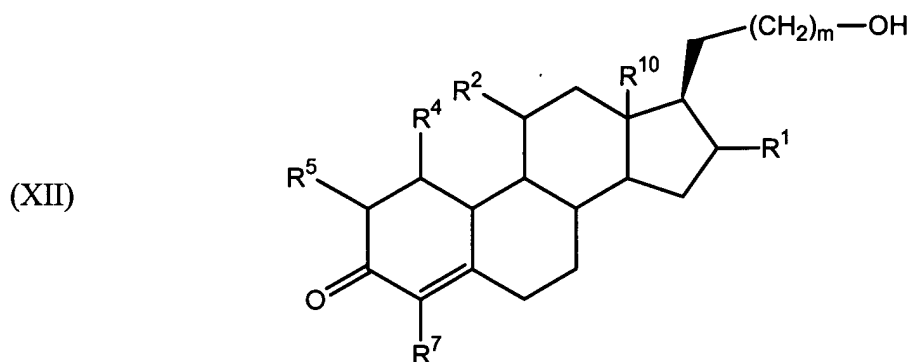
p is an integer in the range of 1 to 7 inclusive;

R^{21} and R^{22} are lower alkyl or are linked together to form a five- or six-membered

heterocycloalkyl ring; and

Q^1 , Q^2 , Q^3 , and Q^4 are independently selected from the group consisting of hydrogen, hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino, said method comprising:

(a) providing a starting material having the structural formula (XII)



(b) protecting the -OH group and the oxy group with protecting groups, thereby

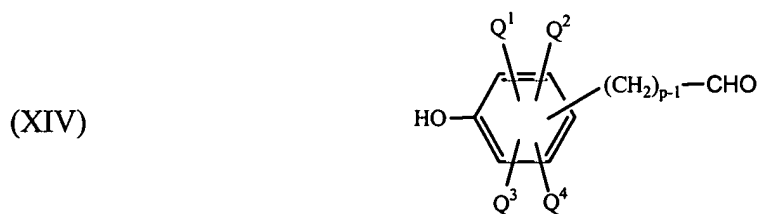
converting the compound into a diene;

(c) deprotecting the oxy group to form a dienone;

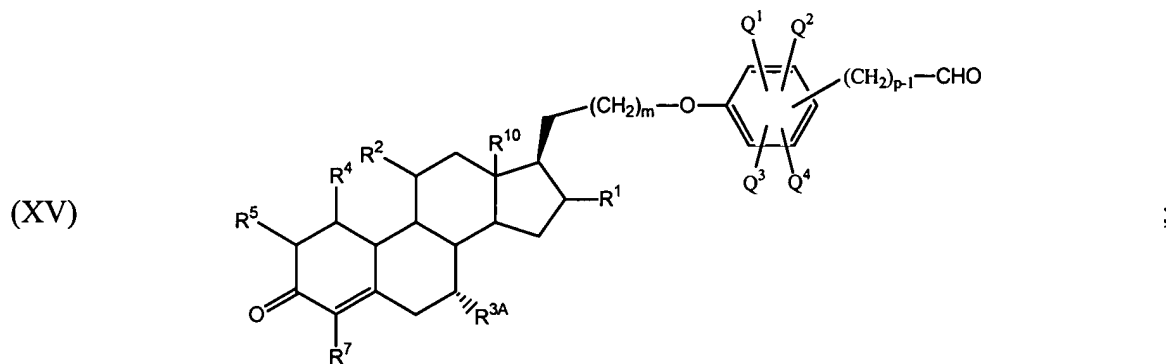
(d) contacting the product of step (b) with an alkyl lithium in the presence of a lithium halide, to provide a 7α -alkyl substituent;

(e) deprotecting the -OH group;

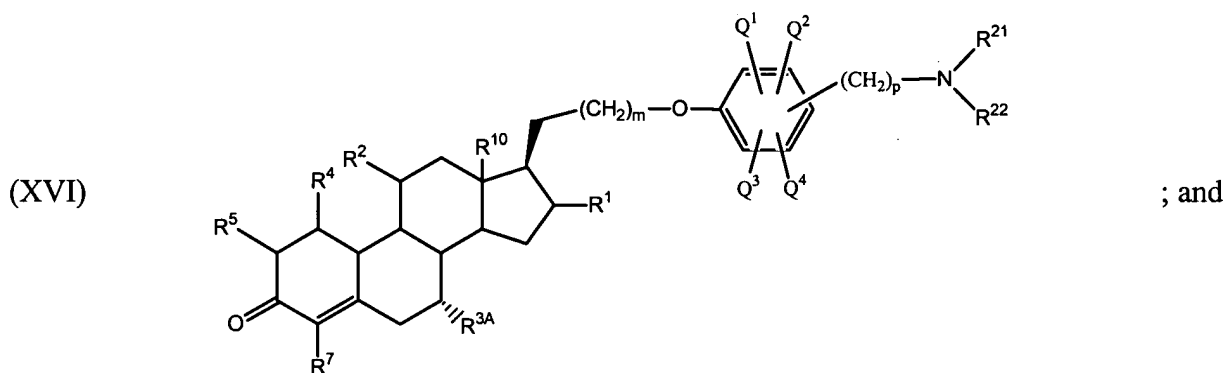
(f) effecting reaction between the -OH group and an aldehyde having the structural formula (XIV)



to result in an intermediate having the structural formula (XV)



(g) treating (XV) with an alkylamine having the structure $\text{HNR}^{21}\text{R}^{22}$ under reaction conditions effective to produce the amine (XVI)



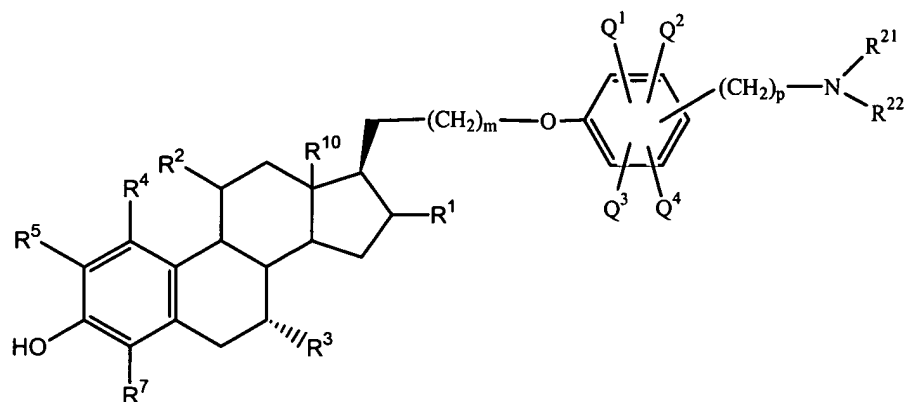
(h) oxidizing and thereby aromatizing the A ring by reaction with a suitable oxidizing agent or agents.

33. The method of claim 32, further including (i) treating the product of step (h) with an acid to produce an acid addition salt.

34. A method for synthesizing an anti-estrogenic steroid having the structural formula

(XI)

(XI)



wherein:

R¹ is CR¹¹R¹², wherein R¹¹ and R¹² are hydrogen or lower alkyl, and when R¹ is absent, R¹ is hydrogen or alkyl;

R² is selected from the group consisting of hydrogen, hydroxyl, alkyl, and -OR¹³

wherein R¹³ is alkyl;

R^{3A} is lower alkyl;

R⁴, R⁵, R⁶, and R⁷ are independently selected from the group consisting of hydrogen and lower alkyl; and

R¹⁰ is methyl or ethyl;

m is zero or 1;

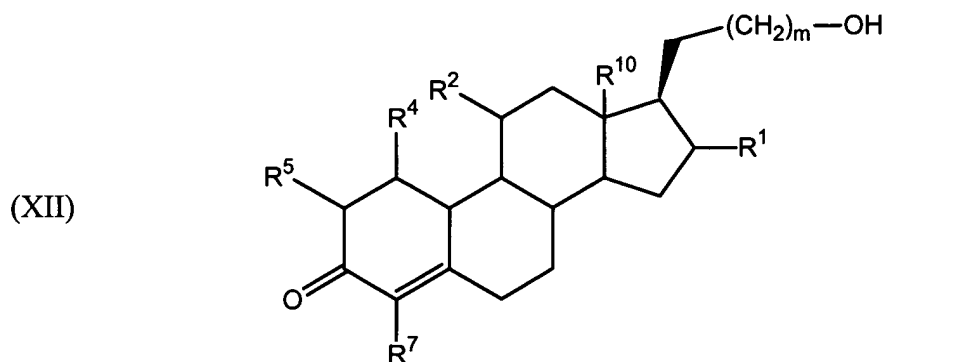
p is an integer in the range of 1 to 7 inclusive;

R²¹ and R²² are lower alkyl or are linked together to form a five- or six-membered heterocycloalkyl ring; and

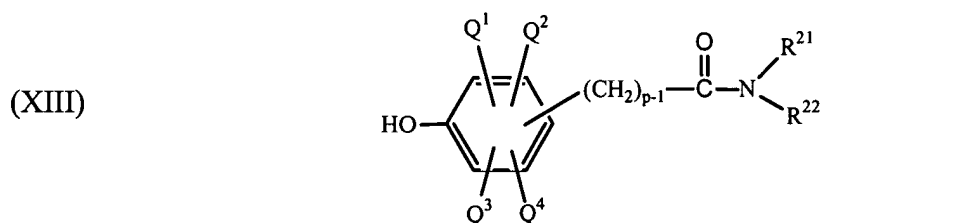
Q¹, Q², Q³, and Q⁴ are independently selected from the group consisting of hydrogen, hydroxyl, carboxyl, alkoxy, alkyl, halogen, amino, and alkyl-substituted amino,

said method comprising:

(a) providing a starting material having the structural formula (XII)



10 (b) converting the -OH group to an -O-LG moiety wherein LG is a leaving group displaceable by nucleophilic attack, and displacing LG by reaction with a hydroxyl-containing compound having the structural formula (XIII)



20 (c) oxidizing the A ring to form a diene and protecting resulting the 3-hydroxyl group with a protecting group;

(d) converting the protected 3-hydroxyl group into an oxo group, thereby forming a dienone;

(e) contacting the product of step (d) with an alkyl lithium in the presence of lithium halide, to provide a 7 α -alkyl substituent; and

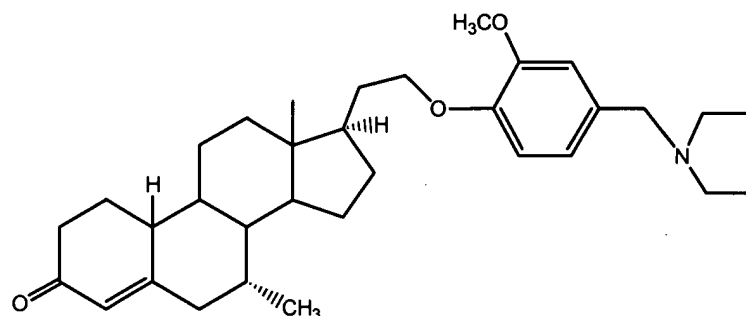
25 (f) reducing the compound so provided to remove all keto moieties.

35. The method of claim 34, further including (g) treating the product of step (f) with an acid to produce an acid addition salt.

36. A pharmaceutical composition for administration of a therapeutic agent, comprising a therapeutically effective amount of the compound of claim 20, in combination with a pharmaceutically acceptable carrier.

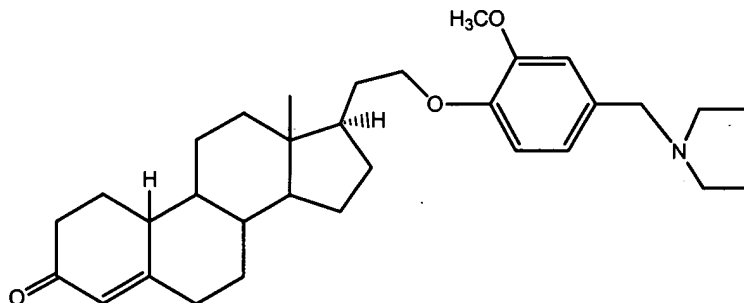
5 37. A pharmaceutical composition for administration of a therapeutic agent, comprising a therapeutically effective amount of the compound of claim 21, in combination with a pharmaceutically acceptable carrier.

10 38. A pharmaceutical composition for administration of a therapeutic agent, comprising a therapeutically effective amount of a compound having the structural formula



15 or a pharmaceutically acceptable acid addition salt thereof, in combination with a pharmaceutically acceptable carrier.

20 39. A pharmaceutical composition for administration of a therapeutic agent, comprising a therapeutically effective amount of a compound having the structural formula



25 or a pharmaceutically acceptable acid addition salt thereof, in combination with a

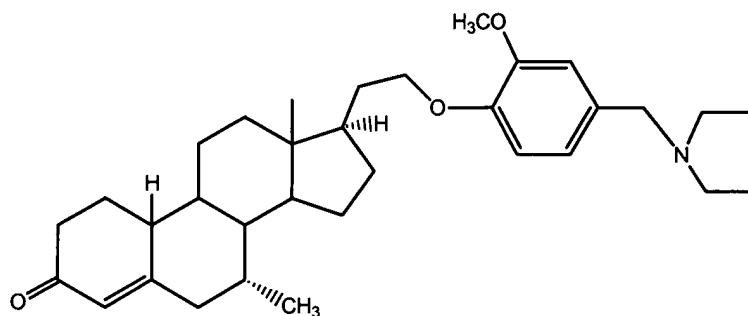
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pharmaceutically acceptable carrier.

40. A method for treating a human patient suffering from a prostate disorder, comprising administering to the patient, within the context of an effective dosage regimen, a therapeutically effective amount of the compound of claim 20.

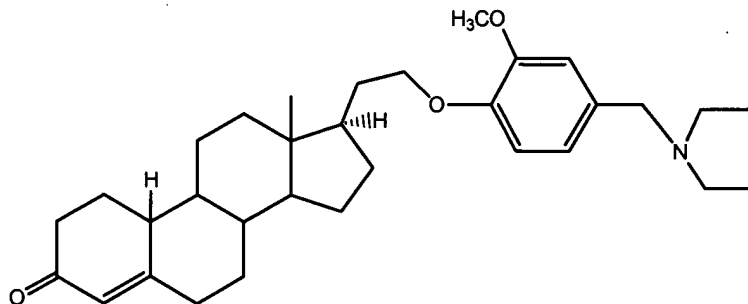
41. A method for treating a human patient suffering from a prostate disorder, comprising administering to the patient, within the context of an effective dosage regimen, a therapeutically effective amount of the compound of claim 21.

42. A method for treating a human patient suffering from a prostate disorder, comprising administering to the patient, within the context of an effective dosage regimen, a therapeutically effective amount of a compound having the structural formula



or a pharmaceutically acceptable acid addition salt thereof.

43. A method for treating a human patient suffering from a prostate disorder, comprising administering to the patient, within the context of an effective dosage regimen, a therapeutically effective amount of a compound having the structural formula



[illegible]

44. A method for stereoselectively adding an alkyl moiety to the 7 α position of a 6
5 keto steroid comprising providing a C¹⁹ or C²⁰ tetrahydropyranyl protected hydroxyl moiety on
the steroid and reacting the protected steroid with an alkylhalide in the presence of base.